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Biodiesel synthesized from waste cooking oil in a continuous microwave assisted reactor reduced PM and NOx emissions

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Abstract

A synergistic effect of the activated limestone-based catalyst (LBC) and microwave irradiation on the transesterification of waste cooking oil (WCO) was screened using a two-level factorial design and response surface methodology. The catalyst was prepared using a wet-impregnation method and was characterised for its surface element, surface morphology, surface area and porosity. The reaction was performed in a purpose-built continuous microwave assisted reactor (CMAR), while the conversion and yield of biodiesel were measured using a gas chromatography. The results showed that the catalyst loading, methanol to oil molar ratio and the reaction time significantly affect the WCO conversion. The optimum conversion of oil to biodiesel up to 96.65% was achieved at catalyst loading of 5.47 wt%, methanol to oil molar ratio of 12.21:1 and the reaction time of 55.26 min. The application of CMAR in this work reduced the transesterification time by about 77% compared to the reaction time needed for a conventional reactor. The biodiesel produced in this work met the specification of American Society for Testing and Materials (ASTM D6751). Engine test results shows the biodiesel has a lower NOx and particulate matters emissions compared to petrodiesel.

Keywords

PM and NOx emissions; Biodiesel; Microwave; Limestone-based catalyst; Waste cooking oil; Optimization